PLASTIC PACKAGING FOR PRODUCE PRODUCTS

BACKROUND OF THE INVENTION

Field of the Invention

This invention relates to packaged produce products which are packaged in polyamide films, especially for fruits and vegetables.

Description of the Prior Art

Packaging of fruits and vegetables using plastic packaging films is well-known in the art. Fresh vegetable and fruit produce are often packaged at the grower level for shipment to end users. Such produce needs a moisture permeable packaging material to permit moisture condensation to escape the sealed package for extended shelf life, enhanced product maturity, enhanced appearance, reduced spoilage, as well as increased harvest yield and to permit better in-transit shipment packaging in cubes. The produce is sold for food service or institutional uses, as well as for retail sale and consumer use.

It has been suggested to perforate the films, such as by mechanical or laser perforation, in order to permit gases that are generated by the produce to escape at various rates. This aids in produce maturity, appearance and extended shelf life. Among the gases generated by produce in a packaging environment are ethylene, carbon dioxide and oxygen. As a result, the atmosphere surrounding the produce in the package is what is referred to as a "modified" atmosphere.

U.S. Patent 6,190,710 to Nir et al. discloses a method of preserving produce by using a polyamide packaging film that has a certain level of permeability to water vapor, which allows the packaged produce product to be contained in a specified gaseous

atmosphere. The polyamide film is perforated to a desired extent such that no or minimal condensation appears on the surface of the packaging material.

The Nir et al. patent discloses the use of monolayer polyamide films for this application, in particular nylon 6, nylon 66, nylon 6,66, nylon 6/12 and blends of the foregoing as well as blends with other polyamides (e.g., nylon 11, 12 or 6I/6T) or with other polymers and copolymers. However, the films utilized by Nir et al. do not have robust strength when they are heat sealed. Accordingly, it would be desirable to provide a produce package which is formed from a polyamide film but which has stronger heat seals such that the package does not split open either in handling or transit.

In addition, growers and packagers of fresh fruit and vegetable produce commonly package with films of polyolefins only, or blends of polyamides only, or blends of polyolefins and polyamides, but such films do not adequately permeate enough water vapor out of the package. This results in interior water condensation which deteriorates and spoils the produce. It would also be desirable to provide a produce package formed from polyamide film which has excellent water vapor permeability, as well as other desirable gas permeation properties.

SUMMARY OF THE INVENTION

In accordance with this invention, there is provided a packaged produce product which comprises a package formed from at least one coextruded polyamide film comprising at least one first layer formed from a polyamide selected from the group consisting of nylon 6, nylon 66 and blends thereof, and at least one second layer of nylon 6,66 in contact with the first layer, and produce contained within the package, the film being heat sealed via the nylon 6,66 layer.

Also in accordance with this invention, there is provided a packaged produce product comprising a package formed from at least one coextruded polyamide film comprising at least one layer of nylon 6, and at least one layer of nylon 6,66 in contact

with the nylon 6 layer, and produce contained within the package, the package being formed from at least one polyamide film being heat sealed via the nylon 6,66 layer.

The package of this invention exhibits increased heat seal strength and improved transmission of gases to provide a desirable modified atmosphere in the package. It has been unexpectedly found that packages formed from the foregoing coextruded layers exhibit enhanced moisture permeation. This enables shipment to the consumer in significantly enhanced product wholesomeness. In addition, using the coextruded film of this invention results in a package that has desirable packaging properties and higher heat seal strength than packages of similar thickness which are formed from a single layer of nylon 6, for example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As mentioned above, the use of nylon films in produce packaging applications is generally disclosed, for example, in U.S. Patent 6,190,710 to Nir et al., the disclosure of which is expressly incorporated herein by reference.

Other examples of plastic packages for fruits and vegetables, some of which use perforated films, are U.S. Patents 4,886,372; 5,492,705; 5,832,699; 6,296,923 and 6,441,340.

The polyamides useful in the coextruded product of this invention are film-forming polyamides. Monolayer structures of nylon 6 film are available from Honeywell International Inc., for example, under the trademark Capran. Nylon 6 polymers are available from a number of suppliers, including Honeywell and BASF. Nylon 66 polymers are also available from a number of suppliers, such as Du Pont.

Nylon 6,66 is a copolymer containing caprolactam (nylon 6 monomer) moieties and hexamethylene diamine (nylon 66 precursor) moieties. The weight ratio of the nylon 6 moiety to the nylon 6,6 moiety in the copolymer may be any desired amount.

Preferably, the weight percent of nylon 6 moiety in the nylon 6,66 copolymer ranges from about 10 to about 95%, more preferably from about 55 to about 95% and most preferably from about 70 to about 90%. Nylon 6,66 copolymer is available from a number of suppliers, including Honeywell, BASF and Du Pont.

General procedures for production of the nylons useful in this invention are well known to the art. The polyamides useful typically have molecular weights in the range of from about 10,000 to about 100,000.

The coextruded film useful in this invention can be provided by any typical coextrusion process. In a typical coextrusion process, the polymeric materials for the individual layers are fed into infeed hoppers of a like number of extruders, each extruder handling the material for one or more of the layers. The melted and plasticated streams from the individual extruders are fed into a single manifold co-extrusion die. While in the die, the layers are juxtaposed and combined, then emerge from the die as a single multiple layer film of polymeric material. After exiting the die, the film is cast onto a first controlled temperature casting roll, passes around the first roll, and then onto a second controlled temperature roll, which is normally cooler than the first roll. The controlled temperature rolls largely control the rate of cooling of the film after it exits the die. Additional rolls may be employed. In another method, the film-forming apparatus may be one which is referred to in the art as a blown film apparatus and includes a multi-manifold circular die head for bubble blown film through which the plasticized film composition is forced and formed into a film bubble which may ultimately be collapsed and formed into a film. Processes of coextrusion to form film and sheet laminates are generally known in the art. Typical coextrusion techniques are described, for example, in U.S. patents 5,139,878 and 4,677,017.

The coextruded film used in this invention may or may not be oriented. Such orientation includes monoaxial orientation and biaxial orientation. For purposes of this invention, the terms “orienting” and “stretching” shall be used interchangeably. The coextruded may be stretched or oriented in any desired direction using methods known

to those skilled in the art. In such a stretching operation, the film may be stretched uniaxially in either the direction coincident with the direction of movement of the film being withdrawn from the casting roll, also referred to in the art as the "machine direction", or in as direction which is perpendicular to the machine direction, and referred to in the art as the "transverse direction", or biaxially in both the machine direction and the transverse direction. The coextruded film may be oriented by the so-called double bubble process.

As used herein, the term “draw ratio” is an indication of the increase in the dimension in the direction of draw. Preferred draw ratios are from about 1.5:1 to 5:1 in at least one direction and more preferably from about 2:1 to about 3:1 in at least one direction.

As mentioned above, the first layer of the film of this invention is formed from nylon 6, nylon 66 or blends thereof. Nylon 6 is the preferred polymer of the first polyamide layer.

The coextruded films used in this invention may have any desirable thickness. Typically, the combined thickness of the coextruded films ranges from about 1 to about 50 μm, more preferably from about 5 to about 40 μm and most preferably from about 10 to about 30 μm. The thicknesses of each individual layer of the coextruded film may or may not be the same. While the foregoing thicknesses are referenced, it is to be understood that other layer thicknesses may be produced to satisfy a particular need and yet fall within the scope of the present invention. If the coextruded film is oriented, the thickness of the film before stretching is selected such that the desired thickness after stretching is achieved, based on the stretch ratio employed, as is known in the art.

The films useful in this invention may include more than one additional layers. For example, a three layer coextruded film formed from nylon 6/ nylon 6/ nylon 6,66 may be employed. However, it is preferred that the film be formed from a single nylon 6 layer and a single nylon 6,66 layer.

Any of the layers of the coextruded film may incorporate conventional additives. Such additives include, without limitation, oxidative stabilizers, heat stabilizers, antiblock additives, lubricants, release agents, oxidation inhibitors, oxygen scavengers, dyes, pigments other coloring agents, ultraviolet light absorbers and stabilizers, fillers (organic or inorganic), nucleating agents, plasticizers, flame retardant agents and other conventional additives known in the art. Such additives may be utilized in conventional amounts, typically no more than about 10% by weight of the individual film layer.

To enhance the performance of the film in the package, the film is preferably provided with perforations, such as microperforations. These perforations may be made by mechanical means or by a laser. The perforations permit the tailoring of the modified atmosphere in the package to the particular fruit or vegetable in the package, as well as its ripeness, etc.

The coextruded films may be formed into any suitable package which contains the produce. For example, a bag may be made from a single coextruded film which is folded on itself with the nylon 6,66 layer facing inwardly and in which has the sides are heat sealed together along their perimeter. Once the produce is placed in the bag (for example, by the grower), the top of the bag may be heat sealed to itself or merely folded over, depending on the modified atmosphere desired in the package. The top of the bag may be twisted together instead. Alternatively, two coextruded films may be overlapped, with the nylon 6,66 layers facing inwardly, and the side and bottom edges heat sealed together along their perimeter to form a bag. The produce is then placed into the bag and the top heat sealed or not as explained above. In addition to bags, the packages of this invention may be in the form of pouches, overwraps, etc. For heat sealing, any conventional device may be utilized, such as a hot bar, hot wire or thermal impulse.

The coextruded film package of this invention can contain any desired fruit or vegetable. Non-limiting examples include melons, peppers, mangoes, bananas, grapes,

strawberries, lettuce, eggplant, bean sprouts, mushrooms, green beans, cucumbers, carrots, tomatoes, broccoli, corn, flowers, etc.

For example, it has been found that a coextruded film of nylon 6 and nylon 6,66 when employed with a combined thickness of about 15 to about 25 microns (3.8 to about 6.3 mils) provides a film structure that permeates from about 8 to about 20 percent more moisture than polyamide films of similar thickness formed from monolayer of nylon 6 only, nylon 6,12 only and blends of polyamides and polyolefins. The heat seal strength between the nylon 6,66 layers of the structure is preferably between at least about 700 grams, more preferably about 1000 to about 1700 grams, for example, which is stronger than the seal between two nylon 6 layers of similar thickness.

EXAMPLES

The following non-limiting examples serve to illustrate the invention.

Example 1

A two layer unoriented film is formed by coextruding a nylon 6 layer and nylon 6,66 layer. The melt temperature during extrusion is between 465 to 544°F (241 to 284°C) for the nylon 6 layer and between 465 to 480°F (241 to 249°C) for the nylon 6,66 layer. The polymers are extruded as a cast film by a typical cast film extrusion process, with a combined thickness of 75 mils (19μm).

The film is tested for its water vapor transmission rate (WVTR) and its oxygen and carbon dioxide transmission rates, and such rates are compared with those of a single layer of cast nylon 6 film and a single layer of monoaxially oriented cast nylon 6 film. The results are shown in Table 1.

TABLE 1

Film	O_2 Trans. Rate (23C, 65%RH) (cc/m^{2}day)	O_2 Trans. Rate (23C, 90%RH) (cc/m^{2}day)	CO_2 Trans. Rate (23C, 0%RH) (cc/m^{2}day)	WVTR (38C, 100%RH) (g-mils)*
N 6/6,66 coex	63.23	96.70	439	41
N 6 monolayer	40.36	63.30	319	33-37
N 6 oriented	40.35	49.78	342	---

* normalized to 1 mil

Example 2

The film of Example 1 is sealed to itself with a pressure of 40 psi (0.28 Mpa) and a 1 second dwell time, at three different temperatures, with the nylon 6,66 layers being heat sealed together. As a comparison, a monolayer of nylon 6 is similarly tested. The results are shown in Table 2.

TABLE 2

Film	Seal Strength at 400F (g)	Seal Strength at 425F (g)	Seal Strength at 450F (g)
6/6,66 coex	732	1650	1453
6 monolayer	no seal	450	650

The coextruded film is formed into a bag by folding over the film with the nylon 6,66 layer facing inward and heat sealing the two side edges together. Melons are packaged in the bag.

As can be seen, coextruded nylon 6/nylon 6,66 films have higher oxygen, carbon dioxide and water vapor transmission rates than films of nylon 6 monolayer and monoaxially oriented nylon 6 monolayer. In addition, the heat seal strength of the nylon 6/nylon 6,66 coextruded film is significantly greater than that of monolayer nylon 6 films. In addition, packages formed from the film have enhanced moisture permeation which enables shipment to the consumer of produce with enhanced product

wholesomeness. By using the nylon 6,66 layer to be heat sealed to itself (or to another nylon 6,66 layer of another coextruded film), lower seal temperatures can be employed, with stronger seals and a wider sealing window, in addition to increased permeation of moisture and gas.

Having thus described the invention in rather full detail, it will be understood that such detail need not be strictly adhered to but that further changes and modifications may suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.